Edgewood Area - Aberdeen Proving Ground, Maryland 21010-5424
U.S. Army Soldier and Biological Chemical Command

Electro-Optics Laboratory

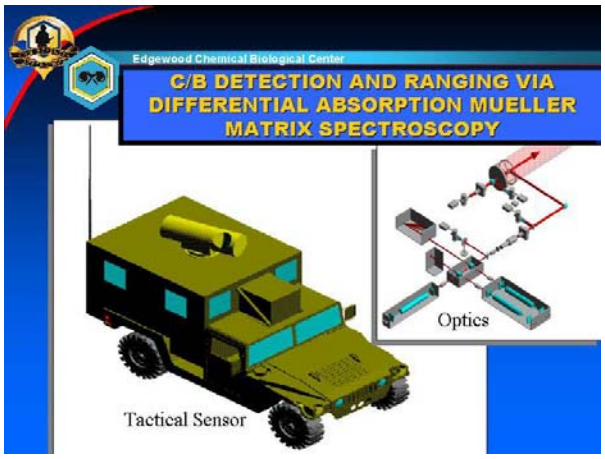
The Edgewood Chemical Biological (CB) Center's electro-optics research laboratory and sensor fabrication facility are located in buildings E3549 B-wing (Berger Laboratory) and E3524, respectively. In these facilities, research and development are conducted on infrared imaging ultrahigh speed solid-state interferometry, multiple beam polarized infrared scattering, thermal luminescence, and their ancillary technologies for future remote sensing systems development. The purpose of these tactical sensors is formation of a first line of defense against CB attack and aftermath scenarios. The following programs are currently under investigation.

Thermal Luminescence Detection

Thermal Luminescence Sensor (TLS) technology addresses the Army's need for chemical defense against liquid nerve and blister agents deposited on the ground (surface contamination state), dispersed in the air (evaporated vapor state), and dissolved in water (agent pollution water monitoring). The TLS concept involves irradiation by magnetron, laser, or high-intensity lamp beam sources whose energy is strongly absorbed into the sample (i.e., contaminated ground, vapor plumb, water pumped into a holding cell, etc) yet outside the detector's optical bandwidth. The irradiating beam causes a build-up in localized temperature and the development of a thermal gradient in the sample. When this gradient reaches a maximum state, the emissivity contrast between contaminant and its background material has peaked. This maximum thermal gradient event corresponds to a detection *window of thermal opportunity*: an irradiation period where detecting the contaminant's thermal spectrum – and thus its identification – is most probable.

In a tactical surface contamination TLS detection system, infrared emissions spectra are accurately measured *in situ* as the sensor traverses a land area via a specially designed optical head comprising TL pump beam source, scanner, TL radiance condenser, and FT-IR spectrometer components. A military HMMWV translates this optics head and a modified S250 shelter houses data handling electronics, a power generator, and air conditioning components. A portable water-monitoring sensor was also designed, built, and tested here at ECBC based on essentially the same TLS method. Both TLS's integrate similar state-of-the-art optics, electronics, software, signal processing, and neural network pattern modules for the rapid and accurate detection of contaminant matter.

Phase-Sensitive Detection



The Phase-Sensitive Detector (PSD) is an infrared photopolarimeter system for standoff detection of combine CB agents in aerosol form and when dispersed onto terrain and man-made surfaces. It exploits the rich electromagnetic field phase information in back-scattering of multiple continuous-wave **CO_2** laser beams.

The technology of polarization-modulated infrared laser beam scattering was developed into a system that measures all 16 elements of the Mueller matrix. The Mueller matrix is a complete optical description of the scatterer – all geometric and physical properties are contained in this 4x4 matrix. They are simultaneously measured by the

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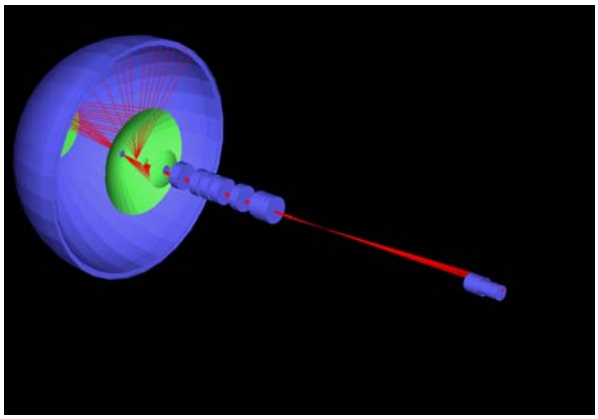
PSD as functions of laser beam energy and back scattering angle. The PSD actually measures differential Mueller matrix elements on-then-off beam energies coinciding with molecular resonance absorption by the contaminant. The differential Mueller matrix elements that show susceptibility on and off absorption states are identifying features of the threat organic compound. Therefore, contaminants targeted by the PSD must exhibit at least one fundamental molecular normal mode of vibration within the radiation bandwidth of its laser transmitter. This type of sensor is also referred to as a differential absorption Mueller matrix spectrometer.

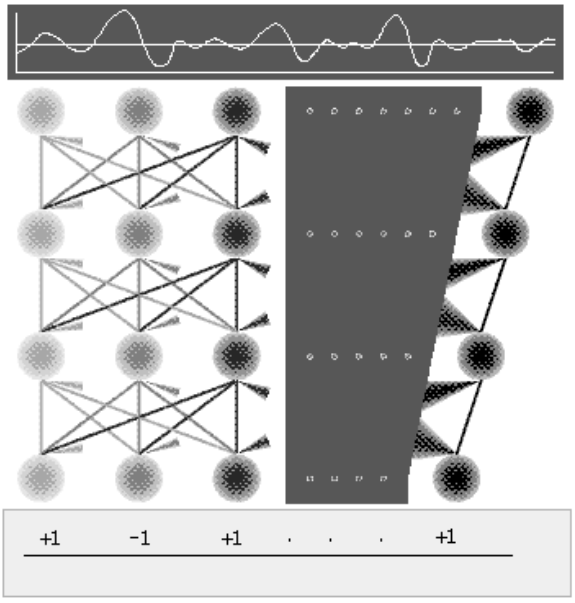
Panoramic-Imaging Solid-State Spectroradiometer



The PANoramic-imaging solid-state SPECtro-radiometer (PANSPEC) system modeled at ECBC provides real-time spectroscopic identification, mapping, and tracking capabilities of a hazardous cloud over a semi-hemispherical field-of-view. It functions as a chemical imaging sensor of most surety vapors.

PANSPEC contains collector, collimator, solid-state interferometer, imager, and focal-plane detector array optical components. The interferometer incorporates a new technology based on photoelastic modulation. Properly configured with the above optics, the solid-state interferometer possesses spectral sensing capabilities well beyond existing systems. A prototype solid-state interferometer unit is now under development.

Artificial Intelligence



Genetic Algorithms (GAs) and Neural Network (NN) models support data processing roles in TLS, PSD, and PANSPEC sensor systems developed here at ECBC. They resolve pattern recognition and cluster analysis issues. Combine NN/GA models were successfully built, tested, and applied to the CB pattern recognition problem. These unique signal processing systems are implemented in Very Large-Scale Integration (VLSI) neural network chips and integrated into their respective sensor signal acquisition and pre-processing electronics.

For additional information, E-mail research.technology@sbccom.apgea.army.mil .

For information on Technology Transfer applications, please contact us by E-mail (technical.outreach@sbccom.apgea.army.mil) or by fax to 410-436-6529.